PROCEEDINGS
HAWAIIAN ACADEMY OF SCIENCE

FIRST ANNUAL MEETING

MAY 19-21, 1926

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HAWAIIAN ACADEMY OF SCIENCE

HISTORICAL SKETCH

Organizations for the discussion of topics in the field of physical science and natural history have for many years been features of the intellectual life of Hawaii. The Hawaiian Medical Society was founded in 1895; the Hawaiian Engineering Association, in 1902; the Hawaiian Chemists' Association, in 1902, enlarged to form the Hawaiian Association of Sugar Technologists in 1922; the Hawaiian Entomological Society, in 1905; the Hawaiian Section of the American Chemical Society, in 1923; and the Hawaiian Botanical Society, in 1924. As centers for the discussion of technical subjects, these organizations serve a very important purpose and have done much to advance knowledge in the fields which they cover, but their membership cannot be appropriately enlarged to include scientists at work in other fields. The increase in the number of scientists in Hawaii and the recognition of the fact that many important scientific problems require for their solution contributions from several fields of research seemed to justify the organization of a society which might enroll all professional scientists in Hawaii and which might encourage amateurs to make their observations accessible by preparing papers for presentation.

Following a consideration of methods and personnel, the Natural Science Club of Hawaii was organized in June, 1921, as a center for informal discussion of scientific topics relating to Hawaii. The seventeen interesting meetings of this Club, held under the guidance of Professor Harold S. Palmer, Secretary-Treasurer, demonstrated its usefulness and pointed the way for the founding of a more comprehensive society for the "promotion of research and the diffusion of knowledge."

With the idea in mind that the proposed organization might become a branch of the American Association for the Advancement of Science, a meeting was called (April 2, 1925) of the members of the Association resident in Hawaii and a committee appointed to formulate plans for a permanent organization.

The Council of the American Association for the Advancement of Science discouraged the plan of forming a local "Branch" or "Division" of the Association, but suggested that an Academy of Science be formed, to affiliate with the Association. At a meeting of the Hawaiian members of the Association on June 10, 1925, the suggestion of the Council was adopted; and a committee consisting of Frederick C. Newcombe (Chairman), Edwin H. Bryan, Jr. (Secretary-Treasurer), Harry L. Arnold, Harold S. Palmer, and Guy R. Stewart was appointed to draft a constitution. At a meeting held July 23, 1925, the constitution was adopted and the following officers were elected to serve until the first Annual meeting to be held in the spring of 1926:

President, Frederick C. Newcombe; Vice-President, C. Montague Cooke, Jr.; Secretary-Treasurer, Edward L. Caum; Councilor (2 years), Otto H. Swezey; Councilor (1 year), Frederick G. Krauss.

At this meeting it was voted that those eligible for charter membership must be members of the American Association, of one of its affiliated societies, or of the local botanical, or entomological societies, and that charter membership rolls be held open until October 1, 1925. During this time seventy-nine individuals signed the Constitution. From October, 1925, to July, 1926, forty-two candidates were elected, giving the Academy a membership of one hundred and twenty-one.

During the year three public meetings were held: on November 9, 1925, Dr. C. P. Berkey, Geologist of the Third Asiatic Expedition of the American Museum of Natural History, spoke on Evidence of Change of Climate in the Gobi Desert; on January 7, 1926, Dr. Edwin G. Conklin of Princeton University spoke on The Mechanism of Evolution; and on March 29, 1926, Dr. Carl M. Meyer of the Hooper Foundation spoke on Food Poisoning and Food Infection.

COMMITTEE ON PUBLICATION

CONSTITUTION

Article I. Name

The name of this society shall be The Hawaiian Academy of Science.

Article II. Objects

The objects of this Academy shall be the promotion of research and the diffusion of knowledge.

Article III. Membership

1. The members of the Academy shall be known as Members and Corresponding Members.

2. Any resident of the Territory of Hawaii, interested in science, shall be eligible for election as a Member.

3. Any person not a resident of the Territory of Hawaii, who is interested in scientific problems relating to Hawaii, shall be eligible for election as a Corresponding Member.

Article IV. Nomination and Election of Members

1. Nomination to membership in either class shall be made in writing to the Council at least two weeks before the Annual Meeting. Each nomination must be signed by three Members of the Academy.

2. The Council shall examine into the fitness of nominees and, at a business session of the Academy, shall recommend for election such nominees as it approves.

3. The Members of the Academy shall vote on the nominees by ballot. Each Member shall prepare his own ballot, and the names of all nominees may be written on one slip of paper.

4. At any time prior to two months before the Annual Meeting, the Council shall have the power to enroll as Members applicants about whose eligibility no councilor has doubt. The names of such persons shall be submitted by the Council at the Annual Meeting for confirmation by the Academy.

5. Election to membership in either class shall require a favorable vote from three-fourths (¾) of the Members present.

Article V. Officers and Committees

1. The officers of the Academy shall be a President, who shall not be eligible for re-election until one year from the end of his last incumbency, a Vice-President, and a Secretary-Treasurer. There shall also be a Council.

2. The Council shall be composed of the officers, the retiring President, and two additional Councilors to be elected by the Members of the Academy.

3. The officers shall be elected annually. The additional Councilors shall be elected, one each year, to serve for a period of two years.

4. An Auditing Committee of two shall be appointed annually by the Council. The Auditing Committee shall examine the financial accounts of the Academy and report their condition at the final business meeting of the Academy.

Article VI. Election of Officers

1. At the final session of the Annual Meeting, the Council shall present a list of nominations for officers and councilors of the Academy. Not more than two names shall be listed for any office.

2. Any Member of the Academy may nominate for any office any Member other than those named in the foregoing list, and such a nomination, if seconded, shall be added to the Council's list.

3. When the list of nominations is complete, each Member shall write on a slip of paper, as his ballot, one name for each position to be filled.

4. The person receiving the highest number of votes for a particular office shall be declared elected.

Article VII. Duties of Officers

1. The President shall preside at the meetings of the Academy, perform other duties provided for him in these rules, and carry out such functions as usually pertain to the chief officer of such a society. He shall deliver an address at the Annual Meeting.

2. The Vice-President shall perform the functions of the President in the absence of the latter.

3. The Secretary-Treasurer shall be the custodian of the records and papers of the Academy, shall keep a record of the Proceedings of the Academy, and make a written report of the year's activity of the Academy at the Annual Meeting.

The Secretary-Treasurer shall collect the dues of the Members, administer all funds, keep a detailed account of the receipts and expenditures of the Academy, and render a written report at the Annual Meeting.

4. The Council, besides performing the duties assigned in Articles IV, V, VI, VII, and IX of this Constitution, shall initiate business for the Annual Meeting, and, in the intervals between the meetings of the Academy, shall strive in every way to promote the interests and efficiency of the Academy as opportunity may be found so to do.

Article VIII. Meetings

1. The Academy shall hold a stated meeting in April or May of each year, to be known as the Annual Meeting. The Annual Meeting shall be announced by a preliminary circular, at least three months before the meeting, calling for papers for the program. Final announcement, giving date and place of meeting, shall be sent out a suitable time prior to each meeting. The program, place, and date shall be determined by the Council.

2. All members desiring to present papers at the Annual Meeting must forward to the Council, at a time which it will set, full titles of all papers which they propose to present, with a statement of the time which each will occupy in delivery. The Council reserves the right to call for an abstract of any paper offered, and to pass upon its fitness for the program.

3. Special meetings of the Academy may be called by the Council. A meeting must be called by the Council upon the written request of ten Members.

4. Stated meetings of the Council shall be held coincidently with stated meetings of the Academy. Special meetings of the Council may be called by the President at such times as he may deem necessary.

5. At stated meetings of the Academy the Members present shall constitute a quorum.

6. Four members of the Council shall constitute a quorum. The Council may appoint a substitute for any of its members absent from the Island of Oahu, for any member resigned, or for any member indefinitely incapacitated.

Article IX. Publications

The Academy shall encourage the publication of papers, presented at its meetings, in appropriate scientific journals. The Council shall give authors such aid as it may in securing publication.

Article X. Dues

1. The dues of Members shall be one dollar ($1.00) per annum, payable within one month following the Annual Meeting. Corresponding Members shall pay no dues.

2. Any Member of the Academy in arrears for eighteen months in the payment of Annual dues shall thereby forfeit his membership in the Academy, provided the Secretary-Treasurer shall have sent the delinquent Member two written notices of the existence of this rule.

Article XI. Order of Business

The order of business at the final session of the Annual Meeting shall be as follows:

a. Call to order by the presiding officer.

b. Reading of minutes of preceding meeting.

c. Announcements.

d. Recommendations from the Council.

e. Report of the Secretary-Treasurer.

f. Appointment of Auditing Committee.

g. Election of Members and Corresponding Members.

h. Reports of Committees.

i. New business.

j. Election of President, Vice-President, Secretary-Treasurer, and additional Councilor.

Article XII. Amendments

This Constitution may be amended at any Annual Meeting by a three-fourths (¾) vote of the Members present, provided that notice of the proposed amendment has been given to the Members a month previously.

MEMBERS

Charter members are indicated by a star (*)

Abel, F. A. E.
Adams, Romanzo
*Agee, H. P.
*Aitken, Robt. T.
Alexander, W. P.
Andrews, Carl B.
*Arnold, H. L.
Baker, R. J.
*Ball, S. C.
*Barnum, C. C.
*Bergman, H. F.
*Bond, Benjamin D.
*Bond, Kennith D.
Bowers, F. A.
*Brown, Elizabeth D. W.
*Brown Forest B. H.
*Bryan, Edwin H., Jr.
Burkland, A. O.
Campbell, Edw. L.
Carson, Max H.
Cartwright, Bruce
*Caum, Edw. L.
Chung, H. L.
*Cooke, C. Montague, Jr.
Cooke, D. A.
Cooke, Richard A.
*Crawford, D. L.
Das, U. K.
*Davis, Arthur L.
*Dean, A. L.
*Degener, Otto C.
Denison, Frederic C.
Denison, Harry L.
*Dewar, Margaret M.
Dickey, Lyle A.
*Dillingham, F. T.
*Donaghho, J. S.
*Edmondson, C. H.
*Ehrhorn, Edw. M.
*Fennel, E. A.
*Ford, Alexander Hume
*Fronk, C. E.
Fujimoto, Giichi
*Giffard, Walter M.
*Gregory, Herbert E.
*Hadden, Fred C.
Handy, E. S. Craighill
Handy, Willowdean C.
*Harl, V. A.
Hartung, Wm. J.
Hauck, Arthur A.
Henke, Louis A.
*Holmes, Henry
Horner, John M.
*Illingworth, J. F.
Jaggar, T. A.
*Johnson, Horace
Judd, A. F.
*Judd, Charles Sheldon
Kangeter, John H.
Katsuki, I.
*Kirkpatrick, Paul
*Kluegel, C. H.
*Krauss, F. G.
*Kutsunai, Y.
*Larrabee, Louise M.
Larrison, G. K.
*Larsen, Nils P.
*Lee, H. Atherton
Livesay, Ruth H.

*Livesay, T. M.
*Lyon, Harold L.
*Lyon, Maude Fletcher
*MacNeil, Wilbur J.
Magarian, M. C.
*Martin, J. P.
*McEldowney, G. A.
*McGeorge, W. T.
McKay, Wm.
*Miller, Carey D.
*Moir, Wm. W. G.
*Morita, Helene T.
*Muir, Fredk.
Neal, Marie C.
*Newcombe, F. C.
*Palma, Joseph
*Palmer, Harold S.
Pinkerton, F. J.
*Pope, Willis T.
Popert, Wm. H.
*Porteus, S. D.
Renton, Geo. F.
Robinson, A. E.
*Rosa, J. S.
*Sideris, C. P.
*Smith, Robt. N.
Spalding, P. E.
*Stewart, Guy R.
*Stokes, John F. G.
*Straub, George F.
*Swezey, O. H.
*Thompson, Herbert L.
*Thompson, Mrs. Herbert L.
Thurston, L. A.
*Topping, D. LeRoy
Tower, Burt Adams
*Van Zwaluwenburg, R. H.
*Verret, J. A.
*Warriner, C. E.
*Weeber, Lorle Stecher
*Weinrich, Wm.
*Weller, D. M.
Wendt, W. A.
*Westgate, J. M.
*Westervelt, W. D.
*Whitney, L. A.
*Wilder, Gerrit P.
*Willard, H. F.
*Wist, J. E.
Withington, Paul
Wood, Edgar
*Yang, Y. C.
Zschokke, T. C.

PROCEEDINGS OF FIRST ANNUAL MEETING

WEDNESDAY, MAY 19, 4:30 P.M.

Business Meeting

PRESIDENTIAL ADDRESS: F. C. Newcombe, The Field of the Hawaiian Academy of Science

WEDNESDAY, MAY 19, 7:30 P.M.

Harold S. Palmer: The form and structure of the artesian areas underlying Honolulu.
Harold L. Lyon: The source, conservation, and increase of artesian water.
G. K. Larrison: The adequacy of artesian water for future supply.
John McCombs: Natural and artificial losses of artesian water.
Max H. Carson: Available surface water.
Discussion led by Herbert E. Gregory and Fred Ohrt.

THURSDAY, MAY 20, 7:30 P.M.

F. G. Krauss: Genetic analysis of *Cajanus indicus* and the creation of improved varieties through hybridization and selection.
Willis T. Pope: Unsettled variations of *Carica papaya.*
Forest B. H. Brown: Lautea, a new genus of the Cornaceae; its probable origin and dispersal in the Pacific.
Forest B. H. Brown and Elizabeth D. W. Brown: *Lepidium bidentoides* n.sp.; a statistical study of its distribution in Polynesia.
Marie C. Neal: Some features of the New Zealand flora.
Otto C. Degener: The hermit crabs of Hawaii.
Stanley C. Ball: The introduction of foreign birds into Hawaii.
John E. Guberlet: Notes on the parasitic fauna of Hawaii.
Otto H. Swezey: The control of sugar cane insect pests in Hawaii by the introduction of natural enemies.
Edwin H. Bryan, Jr.: Insects of the Tanager Expedition.

FRIDAY, MAY 21, 7:30 P.M.

A. L. Dean: Pineapple cultivation as a field for investigation.
W. P. Alexander: Influence of potash fertilization on the sucrose content of sugar-cane.

Douglas A. Cooke: Problems of the outdoor seedling nursery in Hawaii and methods of preserving sugar-cane seed.

Clyde C. Barnum: Studies on the flowering of sugar-cane in Hawaii.

D. M. Weller: Progress report on sugar-cane pollen studies.

Upendra K. Das: Experiments in preserving the life of cut cane.

H. Atherton Lee: The distribution of the roots of sugar-cane in the soil.

Paul Kirkpatrick and M. C. Magarian: A method of direct current vibration galvanometry.

J. S. Donaghho: The duodecimal system of numbering.

Wm. J. Hartung: Repetition in field experimentation. (Read by title.)

F. C. Newcombe: Sensitive behavior of sugar-cane roots. (Read by title.)

SATURDAY, MAY 22, 2:30 P.M.

Herbert E. Gregory: Types of Pacific islands.

E. S. Craighill Handy: The island of Maupiti.

E. S. Craighill Handy: Distribution of ethnographic elements in Polynesia.

John F. G. Stokes: Mountain villages of Rapa.

John F. G. Stokes: A comparison of primitive fabric technique in Oceanica and America.

Willowdean C. Handy: String figures as ethnographic data.

Romanzo Adams: Interracial marriages in Hawaii.

Carey D. Miller: Progress in the study of the nutrition values of the old Hawaiian diet.

C. Montague Cooke, Jr.: Analysis of Samoan land snails.

C. P. Sideris: Hydrophilic colloids.

T. C. Zschokke: A land policy for Hawaii.

Edwin H. Bryan, Jr.: A clearing house for Pacific entomology.

R. H. Van Zwaluwenburg: Some sugar-cane insects of the Pacific coast of Mexico. (Real by title.)

Harold S. Palmer: The viscosity of lava. (Read by title.)

Business Meeting.

A Committee on Publication, consisting of Harold L. Lyon and Harold S. Palmer, was appointed to supervise the publication of the Proceedings of the Academy.

The Committee on Nominations (Wm. W. G. Moir, H. Atherton Lee, and J. S. Donaghho) presented a list of nominees. The balloting resulted in the election of the following officers: President, A. L. Dean; Vice-president, Frederick Muir; Secretary-Treasurer, Edwin H. Bryan, Jr.; Councilor (2 years), Charles S. Judd.

These officers, with Otto H. Swezey, the hold-over Councilor, and Frederick C. Newcombe, retiring President, constitute the Council of the Academy for the year 1926-1927.

The following resolutions drafted by the Committee on Resolutions (Edwin H. Bryan, Jr., Willis T. Pope, and Romanzo Adams) were adopted.

1.—Be it resolved, that the thanks of the Hawaiian Academy of Science be extended to the University of Hawaii in appreciation of its courtesy in allowing the sessions of the first Annual Meeting of the Academy to be held in one of its buildings.

2.—Be it resolved, that the Hawaiian Academy of Science express its thanks to the authorities of Oahu College for the use of Bishop Hall for various public meetings of the Academy throughout the year, and to Mr. W. J. MacNeil for efficient stereopticon service.

3.—Be it resolved, that the grateful thanks of the Hawaiian Academy of Science be given to the Director and Trustees of the Bernice P. Bishop Museum for their offer to publish the Proceedings and abstracts of the papers of the first Annual Meeting of the Academy.

4.—Be it resolved, that the thanks of the Hawaiian Academy of Science be extended to the Honolulu Advertiser and to the Honolulu Star-Bulletin for their press notices concerning the meetings of the Academy.

5.—Whereas, the need of a brief but authoritative handbook on the natural history features of Hawaii is keenly felt by both visitors and students, and

Whereas, there are among the members of the Hawaiian Academy of Science persons qualified to attempt the preparation of such a publication, be it

Resolved, that the Hawaiian Academy of Science heartily endorses the preparation of such a publication, that it sponsor the compilation of data for such a publication, and that it urge its members individually and collectively to cooperate in this undertaking.

ABSTRACTS OF PAPERS

THE FIELD OF THE HAWAIIAN ACADEMY OF SCIENCE

By

F. C. Newcombe

Academies of science are among the oldest associations of men for the pursuit of knowledge. Their aims and activities, whether local or more general, narrow in subject or broadly inclusive, have depended on the will of the membership; and their measure of success has depended on the quality of support accorded by the men and women composing them.

As every organization is guided in its activities by the local conditions which it recognizes, it may be well, in this our first annual meeting, to attempt to recite the opportunities which our local conditions offer, and then to indicate the means by which these opportunities may be utilized.

The Constitution of our Academy states as the purpose "the promotion of research and the diffusion of knowledge." While there is nothing in the Constitution to limit the Academy's field, I shall assume that, for the present, at least, only the so-called natural sciences, including medicine, are expected to participate.

Before launching a new society, it would be well to ask whether the natural science field in Hawaii is already occupied by other organizations. The pedagogical side of science is already looked after by teachers' organizations; and, while the Academy might, at some time, wish to inquire into the adequacy of the equipment for teaching science, the methods, and so forth, would probably best be left to the teachers themselves. The presentation of popular addresses, in exposition of science, should be but occasionally, if at all, attempted by the Academy. This very useful function is now exercised by other organizations and the Academy may well leave this service to them. If we turn our thought next to the single science societies in Hawaii, we recognize the Botanical Society, the Chemical Society, the Entomological Society, the Medical Society, the Medical Association, and perhaps still other societies, all cultivating fields similar to any the Academy might choose. Yes, the fields are similar, but they are not the same, nor are they alike. The Academy of Science offers what no single science can: It offers opportunity for acquaintance and sympathetic understanding of all interested in science in general; it offers opportunity for becoming acquainted with the research going on in all sciences; it offers opportunity for service, each man in his own line willing to impart to his fellow scientists the results of his research; it holds out the prospect of accomplishing by united action what could not be attempted by an organization of narrower scope.

Thus, very briefly stated, are, as I see them, the guiding principles for the conduct of the Academy of Science. They do not constitute a program, but they indicate a field for work without interfering with existing organizations.

From what groups of workers in Hawaii may the main strength of the Academy be expected to be drawn? First of all may be mentioned that group of young workers in the University, in the experiment stations, in industrial institutions, or connected with various plantations who, under the advice of older men, have carried through important series of observations or experiments, and who, under the guidance of the heads of their departments, could prepare accounts of their work to be offered for the annual program. We have two or three such reports in our present program. In the future, the number contributing to such a program can doubtless be increased, and, to my mind, should be increased; for there is no greater stimulus to effort by a young worker than to give him the feeling that he is to be given open credit for his work.

Another group of workers who ought to find congenial association in the Academy, and give to others their stores of knowledge, is constituted by the amateurs. In olden times, the academies of science were maintained almost wholly by this group. In our present program, not more than two papers can be credited to the amateurs. There are amateurs in Hawaii who have collected and studied various parts of the flora, others have related the flora to the old Hawaiian life, still others have collected insects and land snails; and so a long list of amateur work could be enumerated. The Academy would welcome this group of workers, and a way must be found to attract them into the organization.

Consider what a body of workers is constituted by the scientific men in the industries, on the plantations, and in the departments of civic government. They probably exceed the number in all our schools and experiment stations. Their work contains many results of surpassing interest which ought to find a wider publicity than afforded by official reports.

Another group, many of whom are carrying on scientific observation and experiment, is made by the physicians. Several of these are already members of the Academy. Let us hope that future programs will find their names in the list; for much of their work is of value, not only to technical medicine, but also to general biology and other sciences.

The last group to be considered is made up of the specialists working in institutions in which research is a leading motive. In the present day, professionals are sure to constitute the larger part of the productive membership in any scientific society. If we examine our program, we shall find in the total of forty papers, five-sixths are from these professionals. If again we count the papers according to subject, we shall find that fourteen are on plant studies, eight on animal studies, five on water supply, five on ethnology, three on physics, three on physiography, and one on chemistry. The sciences represented in the program are not represented at all in the proportions of the numbers of workers in the corresponding sciences. These two-fold inequalities, just noted, are not inherent either in the scientific institutions or in the sciences, but are probably merely accidents of the time. Some of the professional scientists may feel that an academy has no claims on them, or no advantages to offer them, seeing that they already have their single science society before which their contributions may be read, or they must make their results known in their official reports to the institution employing them. To the first objection it may be replied that the Academy should make no effort to compete for papers with the single science societies, but that some papers might properly by choice come before the society of broader interest, because of their bearing on more than the single science. Considering the claim of the Academy on those who make only official reports, even though such reports are printed in the literature of the institutions concerned, it may be said that such investigators often make discoveries, or work out methods, of interest to general science, though they may not be of immediate practical value. Papers embodying these discoveries should be given by printing to the scientific world, and many such papers would find their proper place in the program of the Academy.

In addition to the foregoing arguments for the existence of an Hawaiian academy of science, is still another, the validity of which all will acknowledge. It is this: that several sciences with workers in Hawaii have no organized society. Among such are mathematics, physics, astronomy, geology, geography, general zoology, agriculture, ethnology, and psychology; yet these sciences have furnished half the papers in our present program. The Academy gives them a society.

Summarizing very briefly the argument for the existence of the Hawaiian Academy of Science, the following points may be presented:

The Academy should be so conducted as to offer congenial association for all interested in science in Hawaii.

The Academy provides a society for more than a half dozen sciences before without a society in Hawaii.

The Academy offers its facilities and solicits the adherence of the young research worker, of the large body of amateurs, of the physicians doing research, of the scientific specialists in the industries and on the plantations, of the scientific staffs of the half dozen research institutions of Honolulu, and of the investigators in government departments.

In the meetings of the Academy, all scientists in Hawaii will have an opportunity to present the results of their studies to their fellows, to state their problems, to learn of the work and problems of their fellows in other sciences, and thus to contribute to the solidarity of science in Hawaii, to the good of Hawaii, and thus also to do all that can be done to overcome the scientific isolation which our geographical isolation necessarily entails.

Besides these benefits of contact, there may be other opportunities presenting themselves to the Academy for usefulness. The natural features of the Hawaiian islands in plant and animal life, in geology and physiography, the natural resources of the islands, the development of movements now going on in agriculture, in industry, in education, in sociology, and in esthetics, in some or all of these, and in other ways not now perceived, the Academy may be called upon to bear a part.

THE FORM AND STRUCTURE OF THE ARTESIAN AREAS UNDERLYING HONOLULU

By

Harold S. Palmer

Artesian water is found only in bodies of pervious rock which slope from a high intake area down to a lower region where they are covered by impervious rocks. Water absorbed at the high intake area flows down through the pervious body beneath the impervious cap rock. If escape at the down-slope end of the pervious body is prevented, the water will be impounded and will develop artesian pressure. In most artesian regions the escape is prevented because the distal end of the pervious body (*a*) is turned up to a high elevation, or (*b*) thins out between impervious bodies of rock, or (*c*) changes laterally from a pervious to an impervious texture.

At Honolulu the flow lavas of the Koolau Range extend southward under the city and on seaward to great depths. They constitute the pervious water-bearing rock. Superposed on them is a body of coastal plain sediments, which, though heterogeneous in detail, as a whole act as an impervious cap. Escape of water at the down-slope edge of the cap is prevented by the back pressure of sea water, which is about one-fortieth denser than fresh water. The principle is like that by which different fluids rise to different heights in the arms of a U-tube, the heights being inversely proportional to the densities. In consequence of this principle, there is a body of fresh artesian water which extends about forty times as far below sea level as it does above sea level. Below the fresh water zone and extending under the whole of the island of Oahu is a zone in which the rock pores are filled with sea water.

When artesian wells were first drilled at Honolulu, the water rose in them about 42 feet above sea level, which implies that the fresh water zone then extended about 1,680 feet below sea level. In 1926 the water rises only about 24 feet above sea level, which implies that the salt water zone has risen so that it is now only about 960 feet below sea level. This is corroborated by the fact that certain deep wells which now yield salt water formerly yielded fresh water. Water has been drawn from the artesian system faster than it has been replenished by absorption of rain.

Curves showing the variation of artesian head from time to time show that the head is highest after heavy rains and lowest at the end of prolonged droughts.

THE SOURCE, CONSERVATION, AND INCREASE OF ARTESIAN WATER

By

HAROLD L. LYON

The upper slopes of the Koolau Mountains constitute the watersheds which gather the water that falls as rain and deliver it into our artesian basins. All of the water that soaks into the ground on these watersheds may be considered as on its way into these basins.

Under primeval conditions, the watersheds of the Koolau Mountains were covered with a heavy rain forest, protecting a dense undergrowth of ferns and moss, which held back the rain water in a most effective manner. Then the soil was kept in a loose, open condition by the many burrowing roots and a thick mulch of organic matter: in fact, the dense vegetation not only served in itself to check the run-off during heavy rains, but also kept the soil in such a condition that it, too, held back the water and at the same time absorbed it rapidly.

Now, it is well known that through the acts of man and his domesticated animals, the effective area of water-conserving forest on the Koolau Mountains has been greatly reduced; that the remaining native forest is in a diseased and decadent condition throughout its entire extent; that the forest is rapidly becoming more open through the death of native plants and their prompt replacement by Hilo grass; and that the soil is becoming more compact and less absorptive as the nature of the vegetation changes. As the inevitable result of the above conditions, the water-absorbing capacity of our watersheds has greatly lessened in recent years, and will continue to lessen until steps are taken to alter the trend of events on these watersheds.

We must realize that while we are encouraging growth and development that will make ever-increasing demands upon the water in our artesian basins, we are, at the same time, permitting, if not actually fostering, conditions that are constantly decreasing the amount of water entering these basins.

The steps which we can, and must, take to insure the maintenance of our artesian water supply at its present magnitude are obvious. We should at once take effective measures to protect and preserve the forests remaining on the Koolau watersheds; we should make every effort possible to rehabilitate these forests so as to increase their water-holding capacity, and we should add to these forests until we have all lands on these watersheds, not otherwise employed, covered with an effective rain forest.

THE ADEQUACY OF ARTESIAN WATER FOR FUTURE SUPPLY

By

G. K. Larrison

The future water requirements for Honolulu are based on 175 gallons per capita daily after the city is completely metered. The present consumption is about 275 gallons per capita daily.

Estimated Future Population	Estimated Future Water Requirements
1930 — 124,000	22,000,000 gallons daily
1940 — 180,000	32,000,000 " "
1950 — 240,000	43,000,000 " "
1960 — 307,000	54,000,000 " "
1970 — 380,000	66,000,000 " "
1973 — 400,000	70,000,000 " "

The present daily draft on the artesian basin in the area between Diamond Head and Red Hill is about 52,000,000 gallons divided as follows:

Government owned wells—		
Used by the Water Works Department	24,000,000	gallons
Privately owned wells—		
Used for industrial purposes	14,000,000	"
Used for irrigation purposes	9,000,000	"
Used for domestic purposes	3,000,000	"
Loss from leaking wells	2,000,000	"
Total	52,000,000	gallons

The estimated safe draft on all artesian wells in this area is 42,000,000 gallons daily.

Other sources of supply, including mountain springs and tunnels, stream run-off and storage and filtration of flood run-off amount to about 30,000,000 gallons daily.

The total available supply from all sources, which may be utilized before the agricultural interests located outside the Red Hill to Wailupe area will be affected, is about 72,000,000 gallons daily.

The original static head of the artesian wells in the central Honolulu area was about 42 feet above mean sea level. The present static head is about 24.6 feet.

The mean annual drop of the artesian head for the past twelve years has been 0.33 foot.

The estimated head at which the Beretania and Kalihi pumping stations will begin to pump water so salty as to be unfit for human use is 18 feet.

If the present rate of fall of the artesian static head continues, the danger point at the Beretania and Kalihi stations will be reached in about 21 years, and at the Kaimuki pumping station in less time.

The remedy is conservation in all respects, supplemented by: a, complete metering of all water works services; b, acquisition and control by the Territory of all existing artesian wells between Diamond Head and Fort Shafter and the prohibition of drilling additional "private" wells in the Red Hill-Wailupe area.

NATURAL AND ARTIFICIAL LOSSES OF ARTESIAN WATER

By

JOHN McCOMBS

Natural losses are those which occur before the artesian water enters the collection and distribution system and are not under human control. The chief natural loss is that through low level springs and can only be avoided by using this water, thus relieving the direct draft through wells.

Deforestation is a second cause of natural loss by decreasing the absorption of water into the artesian system. The remedy lies in the province of the forester. A third natural loss is due to the diffusion and mixture of the underlying salt water into the fresh water lens. The contact between the two is not a surface but a zone of gradual transition. As the artesian head fluctuates, this zone rises and falls and gradually thickens. The remedy is to build up the artesian head.

Artificial losses are those which occur in the processes of recovery and utilization, and may be classified as complete and partial losses. The complete losses are those in which the fresh artesian water finds its way to the sea without having conferred any benefits, for example the loss through well casings which have corroded, thus allowing the water to escape. The Division of Hydrography has greatly reduced this loss. But the work must be continued since more wells become defective every year. A second type of complete loss is due to leaks in the city distribution system, and accounts for a considerable part of Honolulu's excessive per capita daily consumption of 270 gallons. The Honolulu Sewer and Water Commission expects to reduce this to 175 or even 150 gallons by metering every service connection and by locating leaks in the mains. This wholly avoidable loss is estimated at 9,000,000 gallons a day, of which more than 1,000,000 gallons is due to leaky reservoirs.

The partial losses are those in which high grade artesian water is used where sea water or non-potable water could be substituted. A partial loss of several million gallons a day occurs in condensing steam and in industrial plants where sea water could be utilized with complete success. Commercial irrigation is a very wasteful process. In the cultivation of rice in particular, much water is wasted because of the indifference or ignorance of the irrigators. Another waste is in swimming pools, which use a half-million gallons daily, whereas filtration and chlorination would reduce this to less than a hundred thousand gallons.

Some phases of waste prevention are being carried on well. Others are scarcely touched, but all can be carried through, provided the public can have the facts and will support proper action.

AVAILABLE SURFACE WATER

By

MAX H. CARSON

The available surface water for the Honolulu water supply falls into five classes: (1) normal flow from the valleys immediately behind Honolulu, which yields an average of about 6,000,000 gallons per day; (2) flood flow from these valleys which yields an average of about 9,000,000 gallons per day, only about half of which could probably be stored for use; (3) water which might be collected in ditches along the windward coast from Kalihi north to Waiahole and brought through a tunnel into Kalihi Valley at an elevation of 800 feet, which would yield about 7,500,000 gallons per day; (4) water which might be collected in ditches along the windward coast between Kalihi and Manoa valleys and brought through a tunnel into Manoa Valley at an elevation of 400 to 500 feet, which would yield between 2,000,000 and 3,000,000 gallons per day; (5) water already collected and now brought through the Waiahole tunnel for irrigation purposes, and which should be used only as a last resort, as its loss would cripple the plantation it now supplies. Owing to the growing population along the windward coast and their consequent need for the water, probably only about 4,000,000 gallons per day can be counted on as available from classes 3 and 4. However, considerable additional water probably could be obtained from the tunnels through which this water would be conducted to Kalihi and Manoa valleys.

More exact figures than those given here would require a detailed correlation of stream flow with plans for its conservation. The Honolulu Sewer and Water Commission is now making the necessary investigations.

Since the surface supply of water exclusive of that from the Waiahole tunnel can be expected to yield an amount little greater than that the city is now pumping, the necessity for conservation cannot be escaped through its development.

WATER SUPPLY FOR HONOLULU

By

HERBERT E. GREGORY

Regarding water supply, a popular notion prevails that Providence usually takes care of people; and if Providence fails, mankind is amply able to care for itself. But the amount, quality, and availability of water depends on rainfall and geologic structure—factors over which mankind has no control.

It is possible, however, to learn where water is, how much there is, how good it is, and what it costs to obtain it. With that knowledge Honolulu can wisely plan its future; without that knowledge, expenditure of funds is a gamble and may be definitely injurious. For many years the solution of the water problem of Honolulu has been delayed by the failure to appreciate its seriousness and by political bickering. Fortunately, the solution is now in the hands of a group of competent engineers and scientists, and the duty of the community is to support whole-heartedly the work of the Sewer and Water Commission.

GENETIC ANALYSIS OF CAJANUS INDICUS AND THE CREATION OF IMPROVED VARIETIES THROUGH HYBRIDIZATION AND SELECTION

By

F. G. KRAUSS

The tropical leguminous shrub *Cajanus indicus,* commonly known as the pigeon pea, lends itself admirably to genetic study and improvement through breeding. The species has been subdivided into *C. flavus* D. C., with yellow flowers, self-colored seeds and glabrous pods, and *C. bicolor* D. C., which has the back of the standard red, seeds and pods speckled, the pods pubescent. The varieties vary greatly in many other characters. In genetic studies with a number of pure line varieties, some characters seem to follow definitely the Mendelian Law, thus:

DOMINANT CHARACTERS	RECESSIVE CHARACTERS
Flowers with red standards	Self-colored yellow flowers
Blotched or speckled seeds	Self-colored seeds
Pods blotched with maroon	Self-colored light tinted pods
Pubescent pods	Glabrous pods
Large flat pods	Small round pods
Large seeds	Small seeds
4-5 seeded pods	3-4 seeded pods
Round seeds, slightly flattened	All other seed shapes
Axillary inflorescence	Terminal inflorescence
Perennial habit	Annual habit

Some characters appear to show a blending inheritance, as the crossing of very dwarf with very tall varieties tends to produce an intermediate type, although the crossing of two tall types almost invariably produces a form taller than either parent. Insofar as reciprocal crosses have been studied, this behavior remains constant. Dihybrid crosses appear to adhere rather closely to the 9-3-3-1 ratio.

There has been bred and established a new hybrid form which incorporates many of the desirable qualities which were definitely sought for. This has been for the present designated as New Era, Strain X. The production record of the original mother plant of this new type is as follows:

Number of pods	1430
Weight of pods and seed	1587 grams
Weight of seed	1150 grams
Ratio, weight of seeds to pod	73 percent
Average seeds per pod	4.6
Number of seeds produced	6460

In other words, one seed reproduced itself 6460 fold in one season.

We have every reason to believe that we are now entering upon a clear conception of the heriditary behavior of *Cajanus indicus* to an extent whereby we can apply the science of genetics to practical and far-reaching purposes in tropical agriculture. Should we succeed in producing a hardy type of this valuable but little-known legume from crosses between the old established pure strain New Era "D" and hardy Himalayan types which thrive up to 6000 feet altitude, and there is good reason to believe we may, then will Hawaii have contributed not only to tropical agriculture but also to the vast Temperate Zone agricultural world a field crop second to none in the diversity of its economic uses.

UNSETTLED VARIATIONS OF PAPAYA

By

WILLIS T. POPE

The papaya *(Carica papaya)* is particularly interesting because of the extreme variability of its flowering habits and its fruit forms. Horticulturists have difficulty in establishing and maintaining varieties to a fair degree of uniformity.

The papaya is normally dioecious, but monoecious plants are common, and there are many intermediate forms. Almost any block of seedlings grown from the seed of a single fruit exhibits five or six sexual forms.

Many plants bear fruit one year of a shape different from that borne the previous year. Some plants bear fruits of several different shapes at the same time. Pollination experiments gave no evidence that this change of shape of the fruit was caused by the stimulus of cross-pollination.

Another type of variation is in the color of the flesh of the fruit. The normal color is orange-yellow, but flesh colored, pink, reddish, and rich crimson fruits have been found. Seed from a red-fruited papaya has given rise to plants bearing red fruits and plants bearing the normal orange-yellow fruits. An explanation of these variations seems to be found in the discussion of Chimeras by Babcock and Clausen in their text-book, Genetics in relation to agriculture.

LAUTEA, A NEW GENUS OF THE CORNACEAE; ITS PROBABLE ORIGIN AND DISPERSAL IN THE PACIFIC.

By
FOREST B. H. BROWN

Lautea, F. Brown, new genus in lit.
Lautea stokesiana, F. Brown, new species in lit.
Lautea serrata, F. Brown, new species in lit.

LEPIDIUM BIDENTOIDES, N. SP.; ITS DISTRIBUTION IN POLYNESIA

By
FOREST B. H. BROWN and ELIZABETH D. W. BROWN

Lepidium bidentoides, F. and E. Brown, new species in lit.

SOME FEATURES OF NEW ZEALAND FLORA

By
MARIE C. NEAL

The vegetation of New Zealand is distinctly different from that of any other country. This may be explained by its wide separation from other lands, perhaps since Cretaceous times. Possibility of former connection by land with the Northern Hemisphere also offers an explanation for the character of most of its plants. Immigration by land from the north is judged to have come in two waves, the first wave bringing such primitive forms as conifers, ferns, and beeches, from which descended the present representatives of those groups, the second wave bringing higher forms from the Malay region—ancestors of many plants in the mixed forest of the present day. Besides immigrants by land, some are believed to have arrived overseas, chiefly from east and west.

Two types of forest are found in New Zealand, one type made up of trees of one species principally, the other made up of many different species. To the first type belongs the kauri forest, which exists in the northern part of the North Island and which consists chiefly of clumps of that slow-growing pine; the kahikatea forest, found on swampy ground and consisting chiefly of a taxad; and the southern beech forest. The beeches cover large areas in moist parts of both islands, particularly in the South Island. They include six endemic species. Their dense though small foliage prevents much undergrowth besides their own seedlings, mosses, and a large parasite. The beech family may have originated in North America and in ancient times emigrated by land connections to other parts of the world, developing to higher forms at the place of origin and continuing in primitive forms where it dispersed. The southern beech of New Zealand retains primitive forms. The second type of forest, the mixed forest, is located in the lowlands and includes many of the 1800 endemic vascular species listed. It is made up of a great diversity of species, genera, and families, and of trees, vines, scramblers, epiphytes, and herbs of varied forms and sizes, commonly luxuriant, in places impenetrable. With one or two exceptions, woody plants are evergreen; most of the leaves are small, and in many cases those of distantly related species have a similar appearance; and many of the flowers are small and inconspicuous. Ferns are abundant and range in size from trees to minute filmy plants.

Besides many unique genera and species and forms of plants, many peculiar plant associations exist in New Zealand.

THE HERMIT CRABS OF THE HAWAIIAN ISLANDS

By
Otto C. Degener

In the literature available, eight species of hermit crabs (Paguridae) are reported as occurring in Hawaii. There is evidence to show that three of these determinations are incorrect.

Of the fourteen species of hermit crabs that have been collected in the course of these studies, nine have been identified with moderate certainty, and five are new to science. Thus it may tentatively be stated that three species hitherto reported from Hawaii probably never occurred here, that the range of four known species has been extended to include these islands, and that five new species have been discovered.

One of these undescribed species lives in spray-filled pools near high-tide level, another lives secreted among decaying coral rock, a third usually inhabits living coral heads, and a fourth, belonging to a genus that commonly carries sea-anemones on its borrowed shell, has dispensed with this habit.

Although hermit crabs are marine and pass through a free-swimming larval stage, it is interesting to note that no species found in Hawaiian waters has been reported from the coast of America. Instead, their range extends to the westward from Hawaii. This suggests the former existence of a group of "stepping stone" islands between Hawaii and the Orient, and the absence of similar islands to the eastward.

CONCERNING THE INTRODUCTION OF FOREIGN BIRDS INTO HAWAII

By

STANLEY C. BALL

The native Hawaiian birds, which were formerly numerous both in species and in numbers, are rapidly disappearing. Very few species are holding their own. In general the blame can be laid on the advance of civilization.

Several dangers attend the introduction of foreign birds: (1) they may interfere with the native species, which though not important economically or aesthetically, are invaluable from a scientific viewpoint; (2) they may change their habits, becoming economically detrimental; (3) they may so increase in numbers as to become objectionable; (4) they may consume so many beneficial insects as to offset their destruction of noxious forms.

Many kinds of birds might be brought to Hawaii. Fly-catchers might well be economically beneficial, in devouring such insects as the horn fly, the fruit fly, the melon-fly, aphids, moths, termites, and mosquitoes. The meadow-lark (Sturnella) and the bob-white (Colinus) devour such field pests as cut-worms, grubs, beetles, grasshoppers, and crickets, together with many weed seeds. Both birds are beautiful and their musical calls would be welcome. The recently introduced magpie-lark (Grallina) and willie wag-tail (Rhipidura) are well suited to play a very beneficial role. Should it seem wise to supplement the native Drepanids in coping with the insect enemies of the forest trees, several species of titmice are available. A Japanese form (*Parus varius* ?) has become established on Kauai, and has already proven useful. The downy woodpecker of North America is well fitted to supplement the native Pseudonestor in ridding the koa trees of their boring cerambycid grubs, and the tanagers would feed upon the larvae of geometrid, pyralid and tineid moths in the koa and ohia forests. A handsomer bird than the scarlet tanager (*Pyranga erythromelas*) would be difficult to find. For the gardens and door-yards of Hawaii, birds of the type of the American house wren (*Troglodytes aëdon*) would find rich fare in the abundance of scale-bugs and beetles.

Rules governing the introduction of foreign birds may be briefly summarized as follows: (1) the candidate must have shown no objectionable tendencies in its native habitat; (2) it should be of a species that is constitutionally strong; (3) it should be selected to occupy a specific place in the islands' economy; (4) it should be largely insectivorous; (5) it should not be unduly gregarious; (6) it should confine itself chiefly to lands below the forest zone; (7) the migratory instinct should not be strongly developed; (8) it should come from a country with climatic conditions similar to those of Hawaii; and (9) it should have the recommendation of the United States Biological Survey.

NOTES ON THE PARASITIC FAUNA OF HAWAII

By
JOHN E. GUBERLET

The parasitic fauna of Hawaii is little known.

Superficial investigation of frogs *(Rana catesbiana)* disclosed the fact that worm parasites are very rare; only one specimen of a larval cestode, a Dibothriocephalid, and four intestinal nematodes were secured from twenty-five frogs. Parasitological studies on fishes revealed many species of trematodes, cestodes and nematodes. Examination of several specimens each of mackerel *(Scomber japonicus),* trigger fishes *(Balistapus sp.),* mullet *(Mugil cephalus)* and one species of ulua *(Carangus marginatus)* revealed no worm parasites of any kind. The mahimahi *(Coryphaena hippurus)* is invariably infested with larval cestodes of the order Trypanorhyncha and the genus Aspidobothrium, species probably undescribed. This fish also possesses numerous trematodes, cestodes and nematodes. The sword-fish *(Xiphias gladius),* aku *(Gymnosarda pelamis),* ulua *(Carangus ignobilis)* and kahala *(Seriola purpurascens)* yielded species of trematodes, cestodes, and nematodes which are as yet undetermined.

The mynah birds *(Acridotheres tristis)* harbor two species of tapeworms of the genus Hymenolepis. Fully 75 per cent of these birds are infested. Doves are infested with a species of Hymenolepis while the English sparrows were found to be free from worms. Chickens yielded the same cestodes as found on the mainland by Guberlet in 1916. They are *Choanotaenia infundibuliformis, Davainea tetragona, D. cesticillus,* and *Hymenolepis carioca.* The nematodes found are *Ascaridia perspicillum* and *Heterakis papillosa.* Manson's eye-worm has also been reported. A trematode heretofore not reported from chickens was found in the caecum.

Dogs were found to harbor one species of tapeworm *(Dipylidium caninum)* in great abundance. This cestode is also common in the cats of Honolulu. It frequently has been reported elsewhere from children. The dogs are also infested with a hookworm *(Ankylostomum caninum),* the roundworm *(Belascaris marginata),* and the heart-worm *(Filaria immitis).*

Examinations of cats showed them to be infested with two cestodes *(Dipylidium caninum* and *Taenia taeniaformis);* the dog, hook-worm and a roundworm *(Belascaris mastax).* The rats are infested with *Hymenolepis diminuta.*

Reports from physicians show some human beings to harbor *Ascaris lumbricoides* and *Oxyurus vermicularis*. The liver fluke *(Fasciola hepatica)* common in sheep, has been reported from man. This trematode is apparently a common inhabitant of sheep, goats, cattle, and pigs in Hawaii.

THE CONTROL OF SUGAR CANE INSECT PESTS IN HAWAII BY THE INTRODUCTION OF NATURAL ENEMIES

By

O. H. SWEZEY

Usually the commonest insect pests are not native insects, but immigrants that have arrived through the channels of commerce, and in the absence of the natural enemies present at their home places, have increased so as to become pests in their new home. The major cane pests in Hawaii, with one exception, are all foreign insects.

The entomologists of the Experiment Station of the Hawaiian Sugar Planters' Association have very successfully brought about control of cane pests by the introduction of natural enemies from either the home of the pest, or some other country where natural enemies of insects similar to the pests could be obtained. The principal cane pests and their enemies are listed as follows:

Sugar-cane leafhopper, *Perkinsiella saccharicida* Kirk.

Egg-parasites	*Paranagrus optabilis* Perk., from Queensland, 1904. *Ootetrastichus beatus* Perk., from Fiji, 1905. *Ootetrastichus formosanus* Timb., from Formosa, 1916.
Dryinid parasites of young and adult	*Haplogonatopus vitiensis* Perk., from Fiji, 1906. *Pseudogonatopus hospes* Perk., from China, 1907.
Egg-sucking bug	*Cyrtorhinus mundulus* (Bredd.) from Queensland and Fiji,

Sugar Cane Borer, *Rhabdocnemis obscura* (Boisd.)

Tachinid fly, *Ceromasia sphenophori* Vill., from New Guinea, 1910.

Anomala Grub, *Anomala orientalis* (Waterh.)

Scolia manilae Ashm., from Philippines, 1916.

Armyworm, *Cirphis unipuncta* (Haw.)

Amblyteles koebelei (Sw.), from California, date unknown.
Euplectrus platyhypenae How., from Mexico, 1923.

Tachinid flies	*Chaetogaedia monticola* Bigot, from America, date ? *Archytas cirphisae* Curran, from Mexico, 1924.

Cane Leafroller, *Omiodes accepta* (Butl.) (a native insect)

Microbracon omiodivorum (Terry), from Japan, 1895.
Chalcis obscurata Walker, from Japan, 1895.

INSECTS OF THE TANAGER EXPEDITION

By
Edwin H. Bryan, Jr.

During the spring and summer of 1923 on the Tanager Expedition insects were collected on the chain of small islets and rocks of the Hawaiian group extending northwest from Kauai, and on Johnston and Wake islands. About 200 species of insects have been identified in the material secured; of these about 30 are described as new. A report on these insects is being published by the Bernice P. Bishop Museum.

Several degrees of insect life were encountered. On each island the insect fauna seems to have developed up to the limit of its environment, the limiting factors being variety and extent of the flora, presence or absence of fresh or brackish water, and number and character of other animals present. Insect life was poorest on the low sand islets. That on the higher rocky islets included native remnants in addition to the common, wide-spread species. All endemic species seemed to be more or less closely allied to the insects of the larger Hawaiian islands, except that Wake Island with respect to both fauna and flora is a typical south Pacific atoll. Fewer species were found on Laysan Island in 1923 than in 1912, by the same collector. Between these years this island had become nearly denuded by the ravages of rabbits.

PINEAPPLE CULTIVATION AS A FIELD FOR INVESTIGATION

By
A. L. Dean

There are several important problems connected with the pineapple industry for which solutions may be found through scientific study. In the field of genetics two lines of work are in progress, making use of vegetative and sexual reproduction respectively. In the first we may hope for a general improvement in the character of all planting material and for distinctive improved strains of the Smooth Cayenne variety. Pineapples grown from seed show exceedingly wide variations both in plant and fruit and it should prove possible to develop new varieties. Fundamental studies on the morphology and physiology of the plant are required as the basis for improvements in agricultural practice. Field experiments are in progress on a fairly extensive scale directed to obtaining necessary information on crop rotations and methods of cultivation and of fertilization.

The pineapple is subject to attacks by fungi and nematodes, and to some extent by insects. The control of disease is the most serious problem confronting the industry and the intensive work on methods of protection is imperative.

INFLUENCE OF POTASH FERTILIZATION ON THE SUCROSE CONTENT OF SUGAR CANE

By

WM. P. ALEXANDER

Applications of potash fertilizer improve the cane yields and also increase the sucrose content, under certain conditions on Ewa Plantation where deficiencies of potash are found. Twenty-one experiments, harvested during the past four years, tend to verify such a conclusion. These tests comprised a total of 453 watercourse-sized plots. The juice data are based on continuous samples of crusher juice obtained from all the cane from each plot. Sucrose content has been expressed as quality ratio, that is, the theoretical number of tons of cane required to make one ton of sugar. The first indication, in 1922-23, that the quality ratio was better on the potash plots was questioned, as it was contrary to published data on the subject. Further results, however, substantiated the original deductions.

The tests do not show that potash will improve sucrose on all types of soil. The improvement is mainly confined to a heavy clay adobe soil, poorly drained, deficient in potash and having a high salt content.

In twenty-one experiments where the potash increased the quality ratio 1.1 per cent to 5.6 per cent, 189 out of 290 plot to plot comparisons showed cane from the potash plots to have a higher sucrose content. In thirteen of these, where the quality ratio was improved from 1.5 per cent to 5.6 per cent, the cane yields increased on an average 3.1 per cent, while in 24 experiments showing no appreciable gain in sucrose for the potash treatment, the increase in cane yields were within experimental error.

In the first group of tests, those where potash gave gains in sucrose content as well as in cane yield, soil analyses of seven tests showed an average of 0.016 per cent citrate-soluble K_2O and 0.21 per cent hydrochloric acid-soluble K_2O, against 0.028 per cent and 0.34 per cent for the second group.

The juice was analyzed for potash in 22 tests and showed 0.44 per cent K_2O in the first group and 0.81 per cent in the second group.

To summarize, the results from 38 plant food experiments harvested on Ewa Plantation from 1922 to March, 1926, tend to show that, where there is a deficiency of potash in the soil as recorded by soil analyses and crusher juice analyses, the increase in yield of cane due to potash fertilization is accompanied by an improved sucrose content of the cane juice.

PROBLEMS OF THE OUTDOOR SEEDLING NURSERY IN HAWAII AND METHODS OF PRESERVING SUGAR-CANE SEED

By

DOUGLAS A. COOKE

The development of new varieties by the growing of seedlings is of great importance to the sugar-cane industry. At present seedling work is hampered by adverse weather conditions. The sugar-cane plant tassels from November to January. Because of the rapid loss in vitality of the seed, it must be planted at once. The large number of germination flats to be handled necessitate an outdoor nursery.

The weather conditions during December, January and February which hamper seedling germination and growth are insufficient sunlight, excessive moisture, heavy winds, and drops in temperature below 65° F. If the seed could be preserved until the summer months the weather conditions would be ideal.

In the fall of 1924, four methods of seed preservation were tried. 1. Calcium Chloride: Seed was kept in moisture-proof jars with $CaCl_2$ as a drying agent. 2. Vacuum: Seed was kept in a vacuum of about 28″ in a dessicator with $CaCl_2$. 3. Hydrogen gas: Seed was kept in bottles in an atmosphere of hydrogen gas. 4. Carbon dioxide: Similar to No. 3, except that CO_2 was used instead of hydrogen. Untreated samples of seed were found to lose all vitality after 80 days. After 145 days, method No. 1 gave a germination of 70 per cent; No. 2 gave 90 per cent; methods No. 3 and No. 4 gave no germination. Moisture determinations indicated that the gas methods failed because of a too high moisture content. In this test the original germination was so low (about two plants per flat) that the results were felt to be inconclusive.

In the fall of 1925 the experiments were repeated, using seed which was known to be viable. The bottles were kept at a constant temperature of 68° F.

In order to reduce the moisture content of the seed to be kept in gas, two methods were used. Part of the seed was sun-dried for two and one-half hours before bottling; with the rest, $CaCl_2$ was placed in the bottles. Tassels were cut December 7, 1925, and bottled December 17-21. On May 10, 1926, two flats with 25 grams of fuzz each were planted from each treatment. The original germination of fresh seed gave 1,311 plants per 25 grams of fuzz. After five months the untreated seed gave 1 germination to 50 grams; the results with the treated seed were as follows: $CaCl_2$ alone, 56.6 per cent; vacuum untreated, 3.3 per cent; vacuum sun-dried, 9.0 per cent; H gas with $CaCl_2$, 44.2 per cent; H gas sun-dried, 74.2 per cent; CO_2 gas with $CaCl_2$, 58.3 per cent; CO_2 gas sun-dried, 80.2 per cent.

The use of calcium chloride alone, because it gives a high percentage of germination, and because of its simplicity, is probably the most practical method. Moisture seems to be the limiting factor in loss of vitality of cane seed. Possibly a smaller amount of calcium chloride, which would not be so severe in its drying action, would prove even more successful.

THE FLOWERING OF SUGAR CANE IN HAWAII

By

CLYDE C. BARNUM

The breeding of new high-yielding commercial cane varieties is one of the major projects in sugar cane experimental work. Disease resistance is an essential quality in such of these new varieties as may be adopted for plantation culture. Inbreeding in some varieties and hybridization of others is the present means of propagation. The results of investigations made in the tasseling seasons of 1924 and 1925 indicate which varieties can be used most advantageously for crossing, which varieties can be used in selfing and at what time the flowers are found to be in the most receptive condition. Special technique was developed in carrying on the work which permitted verification of all studies, and observations were made on large numbers of tassels of each variety.

No varieties under study opened new flowers between noon and midnight. The first open flowers on tassels appeared shortly after midnight each day. High relative humidity during the hours from sundown to midnight is apparently essential to normal flowering. When the relative humidity during these hours reached 80 to 90 per cent, the tassels were observed to open the average number of flowers. Open-flower counts were made at regular intervals on several commercial varieties thereby determining the hour of maximum flower emergence.

A single flower on a living tassel of D 1135 cane was observed under the microscope to open, distend the floral parts and extrude pollen from the anthers, which pollen in turn germinated on the stigmatic surface and penetrated the stigmatic tissues, all in 15 minutes. Repeated observations indicated similar brief periods for this complete process.

Strong self-fertile characteristics were observed in the varieties D 1135, H 109, and Badila. In flowers of these varieties the anthers are bright red, from which pollen is discharged concurrently with flower opening, less so, however, with H 109 than with the other two varieties. Some H 109 tassels did not discharge pollen until 7 to 9 a. m. Marked evidence of self sterility was observed in Tip, Lahaina, Striped Mexican, and Yellow Caledonia. These canes all produce yellow anthers which do not dehisce under Hawaiian conditions. No mature pollen grains were observed on these varieties.

The heavy flowering of D 1135, Badila, Lahaina, Striped Mexican, and Tip canes occurred between the hours of midnight and 3 a. m. each night during the six to eight day period of flowering.

Steady rain does not appreciably inhibit the normal flowering of sugar cane tassels. It does, however, inhibit pollen discharge. Large numbers of D 1135 tassels were experimentally restrained from discharging pollen when placed in moisture cages where they were sprinkled at short intervals during the flowering period. Flower opening was normal, but pollen discharge was inhibited until 9 a. m. or until sun and wind dried the tassels between sprinklings. Two strongly self-fertile cane varieties could probably be crossed by this means, provided they were both in tassel simultaneously.

PROGRESS REPORT ON SUGAR-CANE POLLEN STUDIES

By

D. M. WELLER

A knowledge of the amount of pollen shed, the viability of such pollen, the length of time during which viable pollen is shed, and the environmental factors influencing such pollen formation and viability, has a direct and immediate application in the technique of cross-pollination in horticultural varieties of sugar-cane (*Saccharum officinarum*).

Methods previously used for determining viability in pollen have not proven satisfactory because they do not discriminate between viability and maturity (for example, the iodine method), and they are not adapted mechanically for securing proper counts so that viability may be determined upon a quantitative basis, as, for example, the method of using the stigmatic surfaces of such plants as Hibiscus, Ipomoea, and Datura. These stigmatic surfaces are not standardized but are themselves distinctly variable. The failure of pollen to germinate on them can be as easily ascribed to the character of the stigma used as to the non-viability of the pollen grains.

Nutrient media such as agar and sugar solutions are adapted to obtaining quantitative data, as in them the factors of temperature, light, and composition can be controlled, but because the factor of humidity is uncontrolled, comparative data are not obtainable.

The use of different concentrations of sulphuric acid in sealed vials to secure known humidities is a convenient and satisfactory method of securing quantitative data because the factors of humidity, temperature, and light are known.

Temperature and humidity have a definite effect upon the percentage of germination of sugar-cane pollen. The optimum temperature is 22 C., at which temperature the maximum number of germinations occurred at a relative humidity of 96 per cent. If the temperature be raised, the relative humidity at which the maximum germination occurs is lowered, this maximum being correspondingly less than that occurring at 22 C., suggesting an optimum absolute humidity as well as an optimum temperature.

The percentage of pollen germinations from cut tassels decreases rapidly from 5 to 6 per cent on the first day after the tassel is cut and placed in sulphurous acid solution to a fraction of 1 per cent on the third or fourth day.

A higher percentage of viable pollen is shed from growing tassels than from cut tassels, and is shed for a greater number of days. The maximum percentage of viable pollen from growing tassels was 15 per cent, as compared with 5.7 per cent from cut tassels; a 6 per cent germination was obtained with pollen from a growing tassel on the ninth day as compared with a 5.7 per cent germination from cut tassels on the first day.

EXPERIMENTS IN PRESERVING THE LIFE OF CUT CANE

By

UPENDRA K. DAS

An important feature of sugar-cane experimental work in Hawaii is the growing of seedlings of known parentage. This necessitates controlled pollination. Tassels of the variety selected as the male parent are cut in the field and tied to or suspended over tassels of the variety selected as the female parent.

Since tassels cut in the field live for only a short time, experiments were instituted to find some means of preserving them for a longer period. When tassels were not available the experiments were performed with leafy stalks.

It was found that cut stalks kept in water live for a time, when the water is changed and at least one internode cut off each day. This method, however, did not prolong the life of the cut stalks sufficiently.

Suspecting that the growth of micro-organisms was responsible for the death of the stalks, a large number of disinfectants and preservatives were tried.

Of the various chemicals used, a solution of sulfurous acid in the proportion of one part SO_2 in 3,366 parts of water gave the best results. Most stalks kept fresh for two to three weeks in this solution. In some plants an elongation of a foot a month was recorded. Other chemicals, such as sulphuric acid, sodium sulphite, sodium hyposulphite, sodium bisulphite, and mercuric chloride proved to be not nearly so effective as sulphurous acid in their preservative qualities. It was observed that tap water is better than distilled water, and that nutrient solutions together with sulphurous acid are better than the acid alone.

This method of preserving the life of cut cane has already proven useful, and many seedlings have been germinated from seed matured on tassels which have been kept in this solution.

Some varieties of flowers, such as Hydrangea, which will not keep well in water, may be kept fresh for several days in this solution.

THE DISTRIBUTION OF SUGAR-CANE ROOTS IN THE SOIL

By

H. Atherton Lee

Although excellent studies have been made on the character and distribution of roots, the writer knows of no quantitative data on the extent or distribution of cane roots. Attempts to obtain these data by linear measurement have been unsuccessful. In the present studies these data were obtained by weighing the roots.

With cane planted in wooden boxes having wire netting spread horizontally at 6-inch levels, weighing with 5 months old plants of D-1135 cane showed that in loose Honokaa soil 62.6 per cent of all roots were in the topmost 6 inches and 10 per cent in levels below 22 inches, and that in more compact Makiki soil 64.6 per cent were near the surface and 9.5 per cent below 22 inches. A similar test with 1 month old H-109 cane showed that 85.2 per cent of the roots, weighing 1.133 grams, were in the topmost 8 inches of soil, with only 0.2 per cent, weighing .003 grams, below 24 inches. In this experiment the roots arising from the seed piece and from the shoot were handled separately, and it was found that only 3 per cent of the total weight of roots arose from the shoot. One month later this percentage had risen to 76.3, showing that the cane plant begins to form its own root system extensively during the second month after planting.

This method was then modified to permit the study of roots under plantation field conditions. This consisted simply of stalking off a given area of cane row, excavating the soil in 8-inch layers and screening out the roots, which were then washed, oven-dried and weighed. This method, applied to five plants of H-109, 10½ months old, showed that 70.14 per cent of the roots, weighing 976.16 grams, lay in the topmost 8 inches of soil, with 1.18 per cent, weighing 11.47 grams, below 24 inches. The total weight of roots per plant averaged a little over 250 grams. Three month old Lahaina and H-109 cane, five stools each, showed that Lahaina had 80.6 per cent of its roots, weighing 38.3 grams, in the upper 8 inches, and 1.3 per cent, weighing .62 grams, below 16 inches. H-109 had 65.4 per cent, weighing 78.7 grams, in the upper 8 inches and 2.1 per cent, weighing 2.5 grams, below 16 inches. This shows that the H-109 variety roots more deeply than the Lahaina, and also forms about twice as many roots.

Two lots of Yellow Tip cane, 26 months old, were taken; one from a field averaging 35 tons of cane per acre, the other from a field averaging 75 tons. A tabulation shows that, while the root distribution was about the same, the total weight of roots was very different, the latter field having plants with half again as many roots as the former field.

Detailed conclusions cannot be drawn from so few experiments; however, it is felt that the experiments thus far completed show that methods for quantitative study of root distribution, under both laboratory and field conditions, have been developed, and that the sugar-cane plant, at least under Hawaiian conditions, is very shallow rooted.

A METHOD OF DIRECT CURRENT VIBRATION GALVANOMETRY

By

PAUL KIRKPATRICK and M. C. MAGARIAN

If a d'Arsonval galvanometer and a suitable source of current be furnished with a key which is opened and closed at correctly chosen intervals the suspended system will oscillate with increasing amplitude, attaining a maximum which may be many times larger than the steady deflection which the same current would produce. This fact provides a means of extending the range of measurement of galvanometers to much smaller currents than those ordinarily measured.

The maximum deflection attained can be theoretically shown to depend in a certain way upon the constants of the galvanometer and its circuit. The particular relations deduced have been subjected to extensive experimental tests and found correct. (An account of these is to appear in the

Journal of the Optical Society of America and in the Review of Scientific Instruments.)

For the practical application of this method a spring-driven commutator has been devised and constructed. This device serves the function of reversing the current to the galvanometer at intervals equal to one-half the period of the latter. The commutator is adaptable to any galvanometer whose period lies between two and twenty seconds.

The use of this galvanometer confers the greatest advantage when the resistance of the galvanometer circuit is high, under which conditions an increase in sensitivity of from five to eighty fold is to be expected, depending upon the type of galvanometer employed.

THE DUODECIMAL SYSTEM OF NUMBERING

By

J. S. Donaghho

The character for ten, resembling the Greek *phi,* is made by passing the stroke of 10 through the cipher; that for eleven, a V, by bringing the two strokes of 11 together at the bottom. Then twelve is written 10, that is, displacing a digit one place to the left multiplies it by twelve. So twelve and one, twelve and ten, two twelves, two twelves and eleven are written 11, 1φ, 20, 2V, and might be read, in computing, one-teel, ten-teel, twentel, twentel-eleven. Also, three twelves and four, five twelves, eleven twelves and ten, twelve twelves, written 34, 50, vφ, 100, might be read thirtel-four, fiftel, eleventel-ten, and one gross. The rest of the notation, without limit, may be borrowed from the decimal without danger of confusion.

MULTIPLICATION TABLE

1	2	3	4	5	6	7	8	9	φ	V	10	11	12
2	4	6	8	φ	10	12	14	16	18	1φ	20	22	24
3	6	9	10	13	16	19	20	23	26	29	30	33	36
4	8	10	14	18	20	24	28	30	34	38	40	44	48
5	φ	13	18	21	26	2V	34	39	42	47	50	55	5φ
6	10	16	20	26	30	36	40	46	50	56	60	66	70
7	12	19	24	2V	36	41	48	53	5φ	65	70	77	82
8	14	20	28	34	40	48	54	60	68	74	80	88	94
9	16	23	30	39	46	53	60	69	76	83	90	99	φ6
φ	18	26	34	42	50	5φ	68	76	84	92	φ0	φφ	V8
V	1φ	29	38	47	56	65	74	83	92	φ1	V0	VV	10φ
10	20	30	40	50	60	70	80	90	φ0	V0	100	110	120

The duodecimal system shows superiority over the decimal in several respects: (1) the multiplication table up to fourteen can be memorized more easily than the decimal table up to twelve; (2) the tests for divisibility of numbers are much easier; (3) less digits are needed to express large numbers; (4) fractions in frequent use, as 1/2, 1/3, 1/4, 1/6, are expressed with a single digit, and 1/8 and 1/9 with two only; (5) as the month is 1/12 of a year, the computation of interest would be simpler; (b) irrational numbers, like /2, /3, 11, e, and logarithms, when carried to four or more places, give more accurate results.

REPETITIONS IN FIELD EXPERIMENTATION

By

W. J. Hartung

Field trials conducted to test such factors as the effects of different fertilizers, of different varieties of the same crop plant, and of variation in culture, have been a part of agricultural science from the time of its inception. The method pursued in the earlier field trials required that the experiment be repeated on the same plot over a long period of years. There were very few duplications or repetitions of the tests conducted simultaneously. Thus it may be seen why harvests covering so many successive years were necessary when matters dealing with slight differences in crop yields were under consideration. There being but a single test plot, the experimental error was at a maximum, and the results were not conclusive.

The only way to reduce the experimental error and to obtain closer results is by multiplying the experiments, either by repeating them year after year or by increasing the number of plots, preferably both. It is useless to try to measure differences of less than about 20 per cent by comparing single plots, regardless of the size of the plots. The experimental error diminishes with the size of the plot, but the decrease is small when the plot grows above one-fortieth of an acre, and there is not much to be gained by increasing the number of plots above five for each treatment studied. Five plots of one-fortieth of an acre each for each unit of comparison will reduce the experimental error to within 2 per cent of the result. These plots should be arranged in a checker-board fashion. The step from experimental to regular practice may be taken with confidence in the ultimate result, because of the accuracy attained through repetition.

The method is speedy but accurate. It requires more labor and application, but the results attained are sufficient to compensate in full for the additional effort expended.

SENSITIVE BEHAVIOR OF SUGAR CANE ROOTS

By
F. C. Newcombe

Everyone who has made cultures of sugar-cane in water or nutrient solutions, from cane pieces, sprouts, or seedlings, has noticed that the lateral roots from the large descending roots grow upward instead of downward. This unusual direction of growth is noticed whether the jar containing the culture admits light or is covered, as is usual, with a cylinder of black paper. The experimenter, at once suggests to himself several hypotheses to account for the phenomenon; possibly these roots in the cane, in normal conditions, grow upward; or, it may be a chemico-respiratory effect, the oxygen diffusing downward causing the roots to grow toward the greater supply of oxygen; or, it may be a light effect, if the light is not wholly excluded from the containing jar.

If the plant used is allowed to grow its roots in a damp chamber, so that there is an environment of air, the roots turn up just the same. This behavior shows that it is not a chemico-respiratory effect. If the jar containing the base of the plant and the roots is buried in earth while the roots are developing, the roots grow downward. This shows that light has something to do with the unexpected behavior. Are the roots positively phototropic, that is, do they bend toward light? If we are very careful to wrap the jar enclosing the roots of the plant in several thicknesses of opaque paper, and use particular care to see that the top of the jar excludes all light, leaving the bottom of the glass jar uncovered, the roots bend upward just the same. Possibly the roots are negatively phototropic. So an experiment is set up, leaving a narrow slit uncovered on one side of the jar. When, after three or four days, the preparation is examined, it is found that the roots still bend upward and slightly away from the light. The roots are, therefore, slightly negatively phototropic. If next, a culture with roots has the glass jar surely made opaque to light everywhere except in an even ring at the top of the jar, the roots grow upward as before. The response giving the upward curving of the roots, must, therefore, overcome the slight tendency of the roots to turn away from the light. This leads, apparently unmistakably, to the conclusion that the usual positive geotropism of the lateral roots in the dark is changed to negative geotropism in the light. The amount of light required to effect this reversal of response is exceedingly small; so that in ordinary covering of the culture jars enough light enters to give the necessary condition for this reversal. It is not light that causes the bending upward. This is due to gravitation, to which the plant responds differently in light and in darkness. Such behavior is not unknown with other plant members, but this is the only case I know in which the roots reverse their response, by such a change in environment.

TYPES OF PACIFIC ISLANDS

By

Herbert E. Gregory

The topographic features of Pacific islands record the changes experienced by the islands throughout geologic time. These features are evidence of origin, of structure, and of age, and bear on the question of former connections of island with island and of island with continental masses. In the absence in the Pacific region of adequate evidence based on fossils and on rocks, the nature and duration of cycles of erosion furnish material for writing geologic history.

THE ISLAND OF MAUPITI AND THE DISTRIBUTION OF ETHNOGRAPHIC ELEMENTS IN POLYNESIA

(Two papers combined in one)

By

E. S. Craighill Handy

The island of Maupiti, Society Islands, is a favorable place for many types of study. Geologically the island is interesting. It is a coral atoll having in the midst of its lagoon an eroded peak of basalt, with an outcropping dike projecting 800 feet above sea level. The rock on the northwest side of the peak closely resembles granite, has been described as such by early writers, thus suggesting great antiquity for the island. Samples of this rock examined by Dr. Herbert E. Gregory were found to be dense basalt.

For biological study of various kinds, this island should be a favorable spot, because of the close and convenient juxtaposition of low coral island and high volcanic island conditions. It is isolated, not by distance, but by difficulty of access. Its lagoon can be entered only through one narrow crooked pass, navigable by small boats, and by them with assurance of safety only when a gentle east wind is blowing.

The archaeologist finds much of interest on Maupiti. There are remains of the old temples of the eight clans, and of the site of the chief's establishment; and pictographs consisting of turtles carved on boulders of basalt.

Anciently, this small speck of land six miles in circumference and probably never supporting more than a thousand inhabitants, was a small world in itself. There are now about a hundred natives, two Chinamen, and no whites. The old culture was fundamentally one with that of the Society Islands, in its religious, political, social, and industrial systems, and in material culture. But there were certain traits that are distinctive and significant: notably a round house form; the use of the bow and arrow, shield, and club as weapons; the warrior's house; and ceremonial cannibalism. It was observed that *k* is frequently substituted for *t* in the dialect.

Maupiti anciently had four types of houses: (1) rectangular; (2) round; (3) round-ended; and (4) arch-ended. The form and construction of these houses and also a study of the distribution of house types in the Society Islands and throughout Polynesia, indicate that type No. 1, which is characteristic of the marginal region of Polynesia, including Hawaii, the Marquesas, and New Zealand, is the oldest; that type No. 2 is of recent introduction, and that types Nos. 3 and 4, found only in the nuclear area (Society Islands, Tonga, and Samoa) represent later forms that were evolved by combining types No. 1 and No. 2.

MOUNTAIN VILLAGE OF RAPA

By

JOHN F. G. STOKES

Prior to 1800 A. D. the population of Rapa lived in villages artificially terraced on ridge peaks at elevations of from 500 to 1,500 feet. These sites have been referred to in literature as "forts." Though arranged for defense, they were primarily settlements. There are a few other and older sites—natural and very difficult of access—which may be regarded as refuges, and still others which suggest transitions from refuges to villages.

Twenty-five of the sites may be regarded as villages, which had populations estimated as from 25 to 300 or 400 people. Most of them were situated at the junctions of the main and lateral ridges, which, to describe one as an example, were deeply terraced by cutting and filling, until two to four tiers surrounded the adjacent and flattened peak. The peak, somewhat like a pill box in profile, was the house site of the chief of the clan and commanded a view, not only of the rest of the village, but of its approaches and of other villages on the island. The lower terraces, divided by walls into compartments about 20 by 25 feet, housed in descending order the chief's near relations and the rest of the clan.

Separated from the village unit and extending along the main ridge and down the laterals are small isolated house sites—probably outposts. Where the lateral ridges adjoin the sea, larger platforms are found—said to accommodate the warriors. These terraces are well situated for the protection of the cultivated fields and for the defense of the natural approaches to the village.

The system of defense included pitfalls in the more advanced types of villages, but most of the villages depended on such natural defense features as precipices on one or more sides. In addition, the terraces were almost vertically cut to depths of 15 to 40 feet, the banks being in subsoil with a vertical upper facing of closely laid dike prisms.

The water supplies are near, but outside the villages; but as rain is abundant these supplies probably were not important. However, traditions refer to the capture of the water supply as part of the strategy of offense. A system of preserving food for long periods was highly developed.

It is obvious that frontal attacks were seldom successful. Night and surprise attacks are recorded as having been commonly practiced.

Local tradition records that formerly the people lived in peace along the shore. Later, wars arose among themselves, after which they hid in the mountains, hence the mountain villages. Local studies suggest a local development. On this account, comparisons with forms of mountain villages in other oceanic areas can only be of secondary value. There are no close comparisons to be found among the other Polynesians. There is much to suggest that the mountain refuge was an older Polynesian feature. Although the mountain village was most highly developed in New Zealand, its types are not closely similar to those of Rapa. It is possible that the mountain villages of the larger islands of Fiji may resemble those of Rapa.

COMPARISON OF PRIMITIVE FABRIC TECHNIQUE IN OCEANICA AND AMERICA

By

JOHN F. G. STOKES

The figures for illustration and reference include three groups of technique suggesting transitions from (1) wrapped to proto-loom weaving; (2) knotted twined weaving to twined weaving; and (3) macramé to netting. Various examples are to be found in Melanesia, Australia, and the Andaman Islands on the one side, and the Americas on the other, and rarely the more primitive phases are found in Polynesia.

In the higher types of loom work, marked resemblances between Asia and America, both in technique and design, have been noted by others.

Primitive fabric technique is an unsettled question of community of influence or parallel development.

STRING FIGURES AS ETHNOGRAPHIC DATA

By

WILLOWDEAN C. HANDY

String figures, known among us as "cat's cradle," are probably as valuable as ethnographic data as any single element in a material culture. Played in every part of the world and handed down from generation to generation, they are the kind of tribal and racial property which might be expected to furnish clues to the movements and contacts of peoples.

Those so far collected fall into two groups known as the "Asiatic" and the "Oceanic": the Asiatic distributed not only over Asia but also over Europe; the Oceanic common not only to the Pacific Islanders but also to the American Indians. The classification has been made upon the basis of the manner in which the loop is placed upon the hands and the start is made, the two methods differing widely; but the two groups are also characterized by other peculiarities. The Asiatic method requires two players; the Oceanic but one. The familiar "cat's cradle" with its seven sequences are the whole of the Asiatic group; while there are hundreds of complicated figures in the Oceanic group. The Asiatic figures are simply named for common objects; the Oceanic figures are named in allusion to mythological characters, events or objects, and there are often chants and stories connected with their making.

So uniform are the figures of the Asiatic group within their area, that the opportunity for comparative study lies within the Oceanic group. Here, while completed figures may be compared for type, only a thorough comparison of the different stages in the making of the figures will establish identities. Hence the impetus given to collecting by the publication of the Haddon-Rivers vocabulary of descriptive terms. Another element offering itself for comparative study is the significance attached to the playing of the game, whether it be magical, as among the Eskimos and Papuans, or for practical application as patterns in crafts, as among the Marquesans, or for some other purpose. Unexpected connections may sometimes be unearthed by a comparative study of the names, chants and stories accompanying the figures.

It is too early to say that any definite ethnographic contribution has been made by string figure data; but a fuller collection of material accurately recorded may permit of mapping the geographical distribution of figures so as to offer definite suggestions as to racial affiliations and migrations.

INTERRACIAL MARRIAGES IN HAWAII

By

Romanzo Adams

Because of the large and increasing number of marriages between persons of different race in Hawaii, there is coming into existence a rather large number of people of mixed racial origin. All races represented in the Territory are contributing in considerable measure to the mixture. From the standpoint of numbers and variety of mixture, Hawaii is one of the best places in the world for a scientific study of the biological affects of race mixture.

The following facts are cited in support of this thesis. There are in the Territory about 13,000 people of Caucasian-Hawaiian blood and about 8,000 of Asiatic-Hawaiian blood. Together these groups constitute about 7 per cent of the population, but the marriages of recent years have been of such a character that, on the assumption of equal fertility, over 16 per cent of the children will be part Hawaiian. The Chinese have made insignificant contributions to the race mixture for a generation. Now the Japanese are beginning to marry out of their own race in increasing numbers. The Portuguese are marrying out very largely, 20 per cent of the men and 40 per cent of the women in the years 1920-1924. Over 44 per cent of the men of American and North European ancestry marry women of other races. The Filipinos are marrying out in large numbers.

Insofar as certain racial groups such as the Japanese have in times past married more closely within their own group than have others, the cause seems to lie not in any innate racial trait, but rather in cultural traits and in practical circumstances. As all the peoples acquire the English language and common manners and customs, intermarriage is increasing.

In Hawaii there is no law against marriage on account of race. There is little or no discrimination against persons of mixed race. They occupy positions of leadership and dignity in the community. Consequently the biological effects can be studied the more advantageously. Practical achievement depends more on personal qualities and less on social stratification based on race.

A study such as is here advocated should concern itself largely with the Mendelian laws of heredity as applied to persons of mixed race. Are persons of mixed race equal to, or stronger or weaker than the average of their ancestral lines? What are unit traits in the Mendelian sense and which are dominant and which recessive?

Since a study of this sort will require many years and since some of the data will be less available after a few years, it is highly desirable that provision be made for adequate research at an early date.

PROGRESS IN THE STUDY OF THE NUTRITIVE VALUE OF THE OLD HAWAIIAN DIET

By

CAREY D. MILLER

When the Hawaiian islands were discovered, the native people were eating the same foods they had undoubtedly eaten for centuries. The kinds of food they ate and the methods of preparation are rather definitely known. Scientists have given convincing proof of the effect of food on the physical well being of people when that food is eaten for generations. Since the Hawaiians were an unusually fine race of people physically, the nutritive value of their food offers a fertile field for investigation.

Taro (*Colocasia antiquorum esculenta*), previously analyzed for organic nutrients, has been shown to be a good source of vitamins A and B. Making taro into poi does not destroy the vitamin A or B content. The basal food consumption of rats given sour poi daily was greater than that of rats fed fresh poi. This was probably due to the organic acids. Taro is a poor source of the antiscorbutic vitamin. Whether making taro into poi further reduces it, is being determined.

Limu eleele (*Enteromorpha intestinalis*) and limu lipoa (*Haliseris plagiogramma*) have no antiscorbutic value. Limu eleele is a fairly good source of vitamin A, but limu lipoa is a poor source.

The Hawaiians exposed constantly to the ultra-violet rays of the sunshine, were undoubtedly furnished with an abundance of the anti-rachitic factor.

AN ANALYSIS OF SAMOAN LAND SNAILS

By

C. MONTAGUE COOKE, JR.

The Samoan archipelago is not as isolated as the Hawaiian, and if these two groups are of equal age and both populated by drift material, the Samoan should have the larger number of species and genera of land snails. The Samoan Islands have representatives of six families and ten genera of Pulmonata, none of which are peculiar to this group of islands. Hawaii has representatives of seven families and at least thirty-three genera of

Pulmonata, of which two families and twenty-one genera are found in no other part of the world. More than 600 species have been described at present from the Hawaiian islands, and if the whole collection in the Bishop Museum were worked up the record doubtless would show from 900 to 1100 species occupying this region. Samoa has between twenty-five and thirty endemic species of Pulmonata. The probable explanation of these figures is that Hawaii is of far greater age than Samoa, as is shown by the much more diversified evolution that has taken place in Hawaii.

As an aid to the study of the ages of small isolated areas, it appears that the indigenous evolution, which can be fairly accurately determined, that has taken place on each of these areas, furnishes a clue to their relative ages.

HYDROPHILIC COLLOIDS

By
C. P. Sideris

Hydrophilic colloids, obtained from soils, pineapple plant tissues and synthetically prepared, were studied for a number of physicochemical properties.

Both the synthetic and natural soil colloids were found to behave very much alike in the adsorption and replacement of various ions. Polyvalent anions were found to be adsorbed more strongly, and also to replace, monovalent anions, the rate being almost in direct proportion to their valence. The rate of adsorption and replacement was not as definite with cations.

Adsorption and replacement were determined by a quantitative chemical analysis and a determination of the electrical conductivity of the solution. Aliquot parts of solutions were obtained by treating the colloids with a number of separate applications of distilled water, each application being allowed to stay in contact with the colloids for a certain interval, then the supernatant liquid removed, and a second added. The salt concentration of these leachings were found to decrease almost in proportion for the first four or five applications, but to increase very suddenly in the one following, and again assume the same role for the second cycle. During the first four or five leachings the pH value decreased, but with the next leaching, concurrently with the increase in salt concentration, the pH was also increased.

The evidence so far obtained indicates that the release of ions from colloids is of a cyclic type. It shows that the concentration curve falls back to almost its original position after a few leachings.

Certain features of the colloid particle are revealed. The results indicate that the anions are adsorbed on the surface while the cations are adsorbed within the structure of the particle, probably held between the interstices of the micellar. This idea is supported by the electric charge displayed by this group of hydrophilic colloids, and the demonstrated fact that the various hues of reddish color in some of the synthetic colloids are due entirely to the anions and not to the cations.

The changes in pH value, caused by treating aqueous colloidal suspensions with alcohol, furnished a reliable test of the position occupied by the anions or cations in the colloidal particle. Besides flocculating these colloids, alcohol increases the acidity of the resulting solution. This is believed to be due to the release of adsorbed anions and their reaction with the water of the solution. Through the dielectric properties of the water, the enclosed cations convey their electric and magnetic attraction to the surface layer, which in turn adsorbs only ions of an opposite electric charge. Replacing water by alcohol inhibits this conductance and releases the adsorbed anions, which react with the water of the solution and increase the acidity.

When an aqueous suspension of soil colloids is filtered through a Chamberlain filter, the resulting flocculate possesses a considerably less acid reaction. The explanation of this phenomenon is that the adsorbed anions do not pass through the filter, but are retained by the colloids. The filtrate, containing the free cations of the solution, is considerably changed in acidity by the reaction of these cations with the water of the solution. This test also indicates the position occupied by the anions in the colloid particle.

The evidence presented above applies only to inorganic colloids. Organic colloids, such as pentosans and proteins of the pineapple plant, will be discussed in a future publication.

A LAND POLICY FOR HAWAII

By
THEO. C. ZSCHOKKE

So long as agricultural land was abundant, it was permissible for each land owner to use his land as he thought best. When such land is scarce, however, ignorant or unduly optimistic persons clear and cultivate land that is not truly agricultural. Rain and wind cause severe erosion in such areas, and fields covered with rocks, fish-ponds silted up, destructive annual floods, and mountain sides eroded to bed rock are the result of attempting to cultivate what should have been forest land.

The various kinds of land may be defined as follows. Agricultural—land which, for a long term of years, will produce agricultural crops at a profit by ordinary farming methods. Grazing—agricultural land which, because of lack of water, roads, or markets cannot be profitably cultivated, or land of moderate slope upon which cattle cannot start erosion. Forest—all other land capable of supporting tree growth regardless of whether it is forested or not.

In France and Switzerland the owner of steep land cannot do anything which might start erosion or cause slides. Our inherent respect for the sacredness of property rights makes it difficult to establish the principle that no man has a right to use his land to the injury of his neighbor, but such misuse might well cause inexcusable and irreparable injury of which the courts should take cognizance.

Good results probably could be obtained by the appointment of a committee consisting of a geologist, a professor of agriculture, representatives of the stockmen, the pineapple growers and the sugar planters, and the Superintendent of Forestry, which committee would consider each case on its merits, consulting with the land owner at fault, and showing him wherein his acts were injurious to the community. Such a committee should be very influential in reducing the misuse of land to a minimum. If a land owner should persist in using his land to the detriment of the community as a whole, condemnation proceedings could be instituted.

A CLEARING HOUSE FOR PACIFIC ENTOMOLOGY

By

E. H. BRYAN, JR.

The divisions of entomology of special interest in the Pacific are classification, distribution, and the economic relations of insects. Economic relations are much dependent upon classification and distribution. It is necessary to adequately characterize insects in order that they may be recognized by other investigators. And it is important to know their distribution in order to guard against undesirable immigrants, and to know where to seek for natural enemies of species which have already gained entrance into any locality.

Entomology in the Pacific is in its infancy. In contrast to the accumulation of data upon European and North American entomology, scarcely anything is known about the insects of the Pacific islands, excepting Hawaii and New Zealand. The collections made during the past hundred years have been haphazard. The material is scattered through the collections of Europe and America.

Because of the difficulty of obtaining accurate or detailed information on either the identity, distribution, or economic importance of a Pacific insect, there is need of building up a collection of Pacific material, and of forming a local clearing house for Pacific entomology. This plan falls within the scope of the Bishop Museum, which already has extensive collections from various Pacific groups. As a clearing house, that institution hopes by expeditions and cooperation with residents of various islands to procure as complete collections as possible; by contact with systematic workers throughout the world, to see that this material is worked up; and to publish the results in a series of bulletins, which will eventually constitute an insect fauna of the Pacific. To do this successfully will require the cooperation of all persons interested in Pacific entomology.

SOME SUGAR-CANE INSECTS OF THE PACIFIC COAST OF MEXICO

By

R. H. VAN ZWALUWENBURG

The west coast of Mexico, especially that part included in the states of Sonora and Sinaloa, is less well known entomologically than other parts of that country.

Sinaloa is the leading sugar producer in the Mexican Republic and has some 30,000 acres of cane under cultivation, all of it irrigated.

The only serious enemies of the cane are two pyralid moth borers, neither of which occurs in Hawaii. One of these, *Chilo loftini* Dyar, attacks about 85 per cent of all the cane stalks. It bores usually a transverse course just under the rind, with the result that much breakage occurs in high winds. It breeds throughout the year, in a number of members of the grass family, but principally in sugar-cane and rice. It requires about sixty days for a complete generation. Only one native parasite, the braconid *Chelonus sonorensis* Cam., is at all effective, and then only when its host is in rice stalks. Chelonus attacks the egg and issues from the half-grown larva; it completes a life-cycle in about thirty-five days.

The second species of borer is *Diatraea lineolata* Walker. It feeds throughout the year, but lays eggs from May to October only. It probably has less than three generations annually. It attacks principally plant cane, about 60 per cent of the stalks being damaged; in ratoon cane the infestation drops to about 35 per cent. The probable reasons for this drop are: (1) most of the caterpillars are killed when the bulk of the plant crop is milled in mid-winter; and (2) in planting new fields, cuttings of plant cane are used instead of the less infested ratoon cane. Diatraea eggs are heavily parasitized by *Trichogramma minutum* Riley, the only native parasite of any consequence attacking this species.

Of minor importance are: (1) the cane lace-wing bug *Leptodictya tabida* H-S, which is present wherever cane occurs in Mexico; (2) a new noctuid pest *Saccharaphagos mochisa* Schauss, the caterpillar of which makes shallow excavations in the butt of the stalk; (3) the cercopid *Tomaspis postica* Walker; and (4) two armyworm moths, *Cirphis cholica* Dyar and *Cirphis latiuscula* H-S., the larvae of which eat the leaves, particularly of ratoon cane. These two pests are well parasitized by the tachinid flies Archytas and by the chalcid Euplectrus. The large tachinid armyworm parasite, *Archytas cirphisae* Curran (ms.), which has become so firmly established on Oahu, Molokai, Maui, and Hawaii was introduced from Sinaloa in 1924.

THE VISCOSITY OF LAVA

By

HAROLD S. PALMER

Very few data exist as to the viscosity of lava, and therefore any approximate estimate is of value. Laboratory experiments give little hope because of the difficulty of reproducing the effect of evolving gases in actual lava flows.

Engineers measure the viscosity of a fluid by comparing its rate of flow with the rate of flow of water through a standard tube. The laws of hydraulics show that the same method is applicable to the flow in open channels.

At one stage of the Alika Flow of 1919, Dr. T. A. Jaggar observed a velocity of 16 feet per second in a channel 40 feet wide and 20 feet deep, with a slope of 12.5 per cent. The Chezy and Kutter formulas indicate that water filling a channel of these dimensions would have an average velocity of about 155 feet per second. The fastest surface thread, however, would flow about 170 feet per second, or about eleven times as fast as the lava actually flowed. The lava probably had a specific gravity about 1.4, and therefore had 1.4 times as much force driving each unit volume down the slope as would a water stream. It is assumed that the flow was steady, which means that all the force was consumed in overcoming viscosity and none of it was expended to accelerate the lava. Yet it produced a velocity only one eleventh as great as water would have produced. The kinetic viscosity is the quotient of the relative velocity into the specific gravity ($1.4 \div 1/11 = 1.4 \times 11$), or about 15 times that of water.

Six sources of error make this value of the viscosity doubtful, but it seems safe to say that the kinetic viscosity of the lava on this occasion was between 11 and 20 times the kinetic viscosity of water at ordinary temperatures.